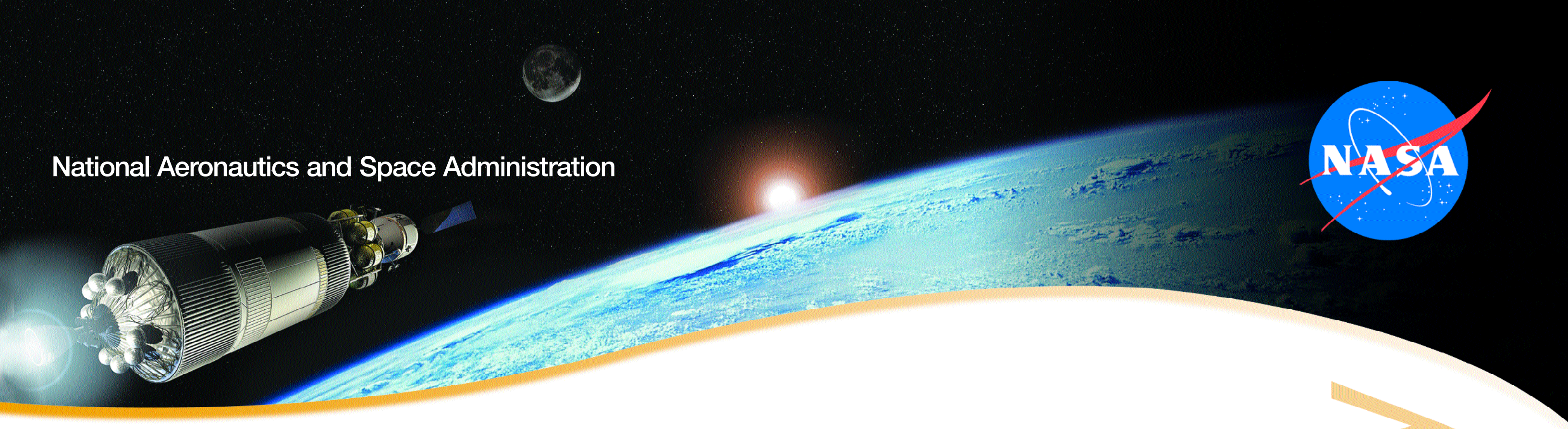


goddard technology

VAPoR

Analyzing Lunar Regolith Using Mass Spectrometry

About the Technology

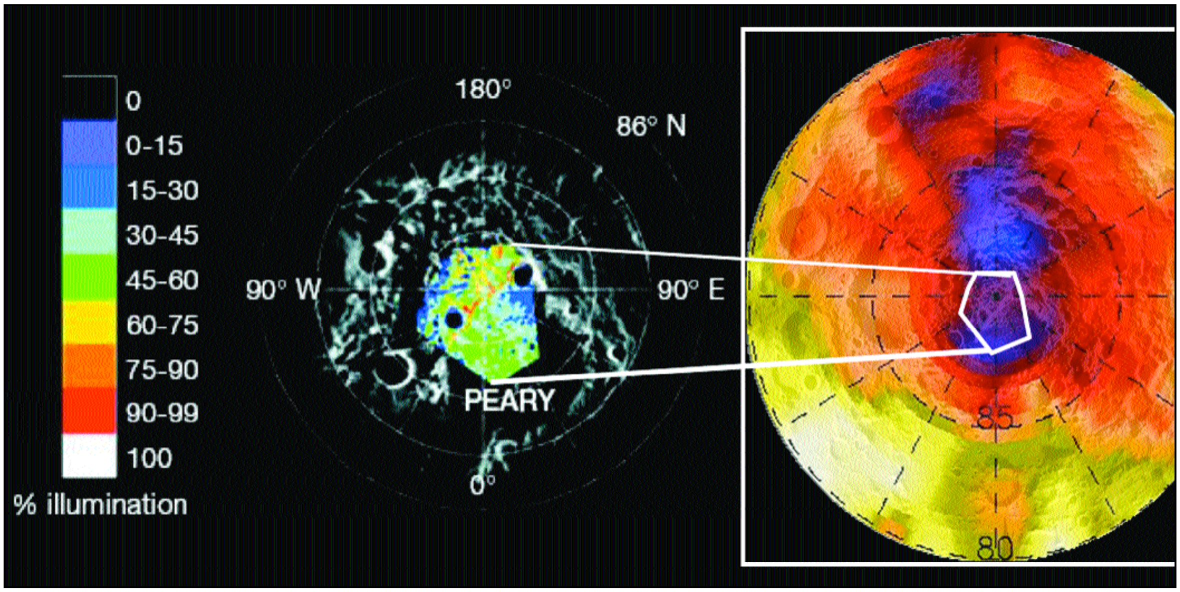
VAPoR (Volatile Analysis by Pyrolysis of Regolith) is a suitcase-size instrument that will investigate the volatile content of lunar regolith, determine the abundance of water and other volatiles, and help to establish their origin (terrestrial, lunar, solar, or exogenous).

Significance of the Technology

Previous missions have detected high concentrations of hydrogen in the Moon's permanently shadowed polar regions. These measurements indicated the possible presence of substantial quantities of water-ice and other volatiles in the lunar regolith. During Apollo 17, an instrument measured a tenuous lunar atmosphere; however, it did not directly measure the regolith for volatiles. As a result, the source of the atmosphere's trace amounts of methane, ammonia, water, and nitrogen remains unknown.

VAPoR would readily detect volatiles released from the regolith. It could differentiate those implanted by solar wind from those delivered by comets and even spacecraft. In carrying out these investigations, VAPoR would help determine the origin(s) of water and other volatiles and provide essential ground-truth data needed to develop future in situ resource utilization (ISRU) technologies and plan human missions to the Moon.

See reverse side



The Clementine solar illumination (left) and the Lunar Prospector hydrogen (right) maps of the Moon's north pole reveal constantly illuminated areas and permanently shadowed craters that contain higher levels of hydrogen. VAPoR's in situ analyses of these areas could determine the origin and abundance of water and other volatiles.

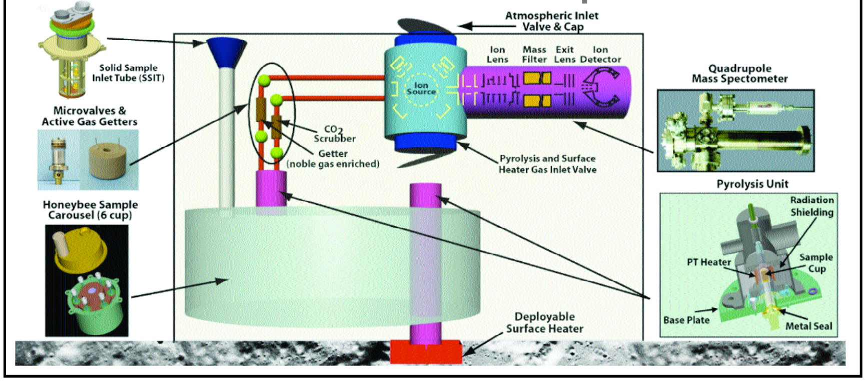
VAPoR

goddard technology

Benefits of the Technology: At-A-Glance

- Provides highly sensitive in situ measurements, both compositional and isotopic, that will help establish the origin of any volatiles released from the lunar regolith.
- Enables in situ characterization of the lunar samples before sample return.
- Carries out its mission at reduced mass, power, volume, cost, and complexity, especially compared with the Sample Analysis at Mars (SAM) instrument suite.
- Constrains the variability and abundance of water-ice in the polar regions for ISRU technology development.

VAPoR Concept



How the Technology Works

Lunar soil samples, delivered to the instrument either by an astronaut or robot, can be heated to high temperatures (>1200°C) inside pyrolysis cups. At these temperatures, the regolith releases water, hydrogen, helium, carbon dioxide, ammonia, nitrogen, and oxygen, which a quadrupole mass spectrometer (QMS) detects. The instrument does not require pumps or carrier gases to analyze these volatiles. To measure the atmosphere, samples can be introduced directly into the mass spectrometer's ion source by molecular diffusion through an atmospheric inlet. A similar QMS is currently under development at Goddard for the SAM instrument on the Mars Science Laboratory (MSL).

To demonstrate the concept, Goddard technologists have developed a prototype system equipped with a Knudsen pyrolysis cell that can heat lunar samples inside a vacuum chamber at temperatures of up to 1400°C. The soil vaporizes and decomposes, releasing water, carbon dioxide, hydrogen, oxygen, and other volatiles. A QMS instrument in direct line of sight with the Knudsen cell can then detect these gases.

Technology Origins

The Goddard instrument team has a long history of developing successful flight mass spectrometers. Recently, the team developed a pyrolysis unit for SAM, one of MSL's instrument suites. The pyrolysis unit will heat Martian regolith so that a gas chromatograph can identify the volatiles. The VAPoR instrument will use a similar technology. Goddard's Internal Research and Development funding and NASA's Lunar Sortie Science Opportunities program both are funding efforts to complete an instrument concept study and build a prototype.

Looking Ahead

The VAPoR team also is collaborating with Goddard's ISRU team to develop a device that combines a pyrolysis mass spectrometer with a gas-collection and storage capability. This instrument will address critical science and exploration goals related to lunar-volatile research.

Contact:

Daniel.P.Glavin@nasa.gov

FS-2007-10-102-GSFC (TT#6)